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Moving ahead from food-related behaviours: an alternative approach to understand household food waste generation

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Abstract

Food waste prevention is a hot topic on the policy agenda. According to available data, urgent measures need to be undertaken to significantly reduce the current generation of food waste. However, it is important to thoroughly understand consumers' behaviour to define measures that will lead to a long-lasting change in the situation. The aim of the present work is to analyse consumer food waste behaviour by means of a model that brings together food-related and waste management variables. To do so, a survey was given to 418 consumers of the metropolitan area of Barcelona. Results show that food waste is directly influenced by purchasing discipline, waste prevention habits and materialism values and indirectly influenced by environmental values. This highlights the importance of addressing the problem from different perspectives and emphasizes the importance of considering this problem as a transversal element for policy makers. We suggest that household food waste prevention and reduction needs to be included as a key element in different policy areas.

36 **Highlights**

- 37 • Food waste conceptual model incorporating food-related, waste management and
38 consumers' values.
- 39 • Waste prevention, purchasing discipline and materialistic values are direct predictors of food
40 waste behaviour.
- 41 • Partial least squares (PLS-SEM) validated the consumers' food waste generation model.

42 **Keywords:** food waste, consumer behaviour, structural equation models, waste prevention

43 **1. Introduction**

44 The Food and Agricultural Organization of the United Nations (FAO), among other institutions,
45 reported that global limitations on food availability would exist in the upcoming years up to 2050,
46 which, combined with current food waste, results in an unethical and unsustainable world-feeding
47 situation. Food waste is an environmental, economic, social and food security problem (Kosseva,
48 2013; Stuart, 2009) that urgently needs to be addressed. The United Nations advocates for it within
49 its Sustainable Development Goals. In particular, goal 12.3 states that “By 2030, halve per capita
50 global food waste at the retail and consumer levels and reduce food losses along production and
51 supply chains, including post-harvest losses” (United Nations, 2015). In Europe, reducing food
52 waste is a key area of the circular economy package (European Commission, 2017).

53 Some work has been done to quantify food waste. FAO's report in 2011 exposed that one-third of
54 all food produced for human consumption is lost or wasted every year (Gustavsson et al., 2011). In
55 Europe and North America, this equals up to 300 kg of food per capita and year along the food
56 supply chain. Moreover, published data revealed that about 50% of the total amount of food is
57 wasted downstream, mainly at the household level (Bio Intelligence Service, 2010; Gustavsson et
58 al., 2011; Katajajuuri et al., 2014; Stenmarck et al., 2016). The most recent study focused on EU-28
59 reports that 92 kg of food are discarded per person and year at households where approximately
60 60% of its volume is edible (Stenmarck et al., 2016).

61 Although food waste occurs along the whole supply chain, consumer food waste has been reported
62 to be a hot spot and has received special attention. Different studies have analysed consumers'
63 behaviour, awareness and the causes of food waste in such countries as Greece (Abeliotis et al.,
64 2014), Canada (Parizeau et al., 2015), Romania (Stefan et al., 2013), Denmark (Stancu et al., 2016),
65 the United States (Neff et al., 2015; Qi and Roe, 2016), Italy (Principato et al., 2015; Setti et al.,
66 2016), Singapore (Grandhi and Appaiah Singh, 2015) and New Zealand (Tucker and Farrelly,

2015). However, despite the increasing interest, the above studies use mainly food-related approaches, leaving waste-related approaches aside. Bearing in mind that the latter is the prevailing approach in food waste prevention campaigns, especially in Europe where food waste legislation is waste oriented (Lucifero, 2016), a more focused analysis on food waste prevention strategies it is necessary in order to identify individual's attitudes, values, behaviours and motivations towards wasting food. Moreover taking into account that food waste is an interdisciplinary issue, it has to be addressed from both waste and food-related perspectives (Kosseva, 2013; Langley et al., 2010). However, the magnitude of the influence of waste and food-related perspectives on consumer behaviour towards wasting food is unknown to date. The aim of the present work is to reach a better understanding of the factors that influence consumers' food waste generation in order to define prevention strategies at the household level and demonstrate that a multidimensional perspective should be undertaken to address the prevention.

Up to date, there has been little attention on the factors driving food waste considering different behavioural dimensions simultaneously. Most of the existing academic literature on food waste either examines a partial dimension or is focused on estimating the amount of food wasted. However, consumer's food waste behaviour is a complex phenomenon build as a result of the interaction of several behavioural aspects. The decision-making process that ends on the behaviour of wasting food is shaped by social, economic and personal factors and is the outcome of the interaction of decisions, values and engagements. One of our contributions to the literature is to design a behavioural framework towards household food waste bringing together the two of the main approaches that define the food waste debate nowadays: waste management and food habits. In addition, we include consumers' values as possible predictors and moderators to complete the model. In particular, we focused on an especially significant region of Europe: the metropolitan area of Barcelona. It is one of the most populated areas of Europe located along the Mediterranean coast, with a growing population accounting for more than 3.2 million people in 2015, and it occupies an area of approximately 636 km², 48% of which is urbanised (AMB, 2015).

This paper is organised as follows. The next section undertakes a literature review to justify why we hypothesise that a variety of actions and motivators could affect the food waste behaviour, arguing that it is not only a food-related issue but a waste management, an environmental concern and materialistic issue, too. This section summarizes the state of the art regarding food waste behaviour at the household level and develops a conceptual model that explains consumers' food waste behaviour. Section three explains the data and method of analysis. The fourth section of the paper

99 reports the main results of the study. Finally, the fifth section discusses the relevance of the results
100 for further research and to define strategies of prevention food waste generation.

101 **2. Theoretical framework: food waste behaviour**

102 Previous literature demonstrate that food waste does not respond to a single behavioural dimension
103 but emerges from a wide variety of actions and motivators (Evans, 2011; Quested et al., 2013;
104 Secondi et al., 2015; Setti et al., 2016; UNEP, 2014). Due to its complexity, studies to date have
105 only considered partial analysis from diverse disciplines. Watson and Meah (2012) emphasize the
106 dichotomy between the necessity of safe and nutritious food and the desire to reduce food waste. In
107 that line, our theoretical framework advocates for a combined approach assembling current
108 evidences on the relevance of food and environmental behaviours as well as selected consumer
109 values to explain consumers' food waste generation. We aim at testing the power of food-related
110 attitudes, waste-management behaviours and selected values (environmentalism and materialism) to
111 explain consumers' food waste behaviours.

112 In this section, the paper first attempts to bring together the published evidence from different
113 studies and the distinct identified behaviours towards food waste and to develop a theoretical model
114 considering three main issues: (i) food-related behaviours, (ii) waste management behaviours and
115 (iii) consumers values. It is important to highlight that this research attempts to test that food waste
116 behaviours are not only the results of food related behaviours but of a combination of food
117 unrelated and related behaviours among other elements. Therefore, we did not focus on specific
118 prevention or values regarding food waste, but on general waste prevention habits that we argue
119 could be also related to the generation of food waste.

120 **2.1. Food-related habits**

121 Household food waste can be considered a food-related behaviour. Some studies intend to
122 determine, by means of different analytical tools, the main causes of food waste generation. The
123 most frequently identified actions that can lead to food waste generation can be grouped in five
124 categories: food purchase, food storage, food preparation, food consumption and lifestyle related to
125 food. Consumers' attitudes, values, knowledge and behaviour towards food might have an effect on
126 the food waste generation (Kosseva, 2013; Parfitt et al., 2010; Principato et al., 2015). We have
127 identified three factors related to food habits: purchasing behaviour, price importance and dietary
128 importance as representatives of food importance towards food waste generation.

129 Some studies have found noticeable conceptual links between food waste and food preferences,
130 such as nutrition and food safety (HLPE 2014), dietary conscientiousness (Parizeau et al., 2015),
131 affection for food (Porpino et al., 2016), food preferences (Bio Intelligence Service, 2010; Canali et
132 al., 2014), domestic routines and habits (Evans, 2011) or the social value of food (Mallinson et al.,
133 2016). Indeed, in the Quested et al. (2011) study, people cited eating a healthy diet as an
134 encouraging factor for reducing food waste.

135 In particular, certain purchasing habits may affect the subsequent household management of food,
136 namely poor planning and shopping routines (Mallinson et al., 2016; Mondéjar-Jiménez et al.,
137 2015; Parizeau et al., 2015; Setti et al., 2016; Stancu et al., 2016; Stefan et al., 2013; Tucker and
138 Farrelly, 2015), excessive buying, (Göbel et al., 2012; Parfitt et al., 2010; Porpino et al., 2015;
139 WRAP et al., 2007) or the symptom of the ‘good provider’, who is trying to have as much variety
140 as possible for all the household members (Graham-Rowe et al., 2014; Visschers et al., 2016).

141 Moreover, food price is another element which could have an influence on consumers’ food waste
142 generation. This topic has not been studied in detail but some works suggested that marketing
143 attractions such as promotions, also named offer temptation (2x1), can alter consumer’s purchase
144 discipline (Mondéjar-Jiménez et al., 2015; Parfitt et al., 2010; Quested et al., 2013; Setti et al.,
145 2016). Moreover, consumer during diverse focus group in Europe pointed out food prices as a
146 possible cause of food generation in the households (Geffen et al., 2016). Finally, Mallinson et al.,
147 (2016) described how a group of consumers who revealed higher levels of food cause were more
148 influenced by promotions and were less price-conscious. However, besides these studies, little is
149 known on the relationship between food price importance and food waste generation.

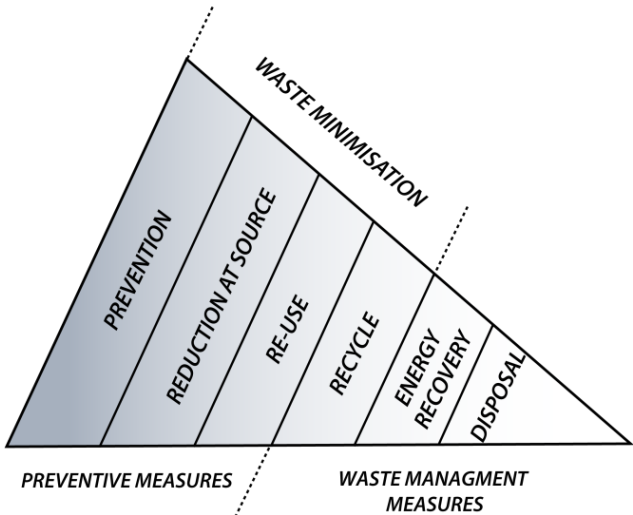
150 According to the aforementioned studies, we synthesize all food-related causes in three main
151 variables, diet importance, price importance and purchasing discipline. The first three hypotheses
152 are outlined:

- 153 • H1: Consumers who reveal a higher concern about the importance of their diet are expected
154 to waste less food.
- 155 • H2: The importance that consumers place to food price is expected to have an influence on
156 consumers’ food waste (the effect negative or positive cannot be pre/established from the
157 available literature)
- 158 • H3: Consumers who reveal a more disciplined purchasing behaviour are expected to waste
159 less food.

2.2. Waste management

Despite the lack of specific studies on food waste behaviours connected with other waste-related activities, some food waste prevention campaigns have emerged from these specific sectors. Regulation of food waste could be characterized as recent and unspecific, even though there are some documents that highlight the urgent need for its reduction. The Waste Framework Directive (WFD-2008/98/EC) (EU, 2008) clearly defines a waste hierarchy (see Fig. 1) and sets a clear waste prevention procedure as a priority. Within the Waste Framework Directive, the distinction between prevention and minimisation could be misunderstood. Therefore, Figure 1 allocates within the waste hierarchy the different preventive measures that encompass prevention, reduction and re-use and waste management measures from recycling to disposal.

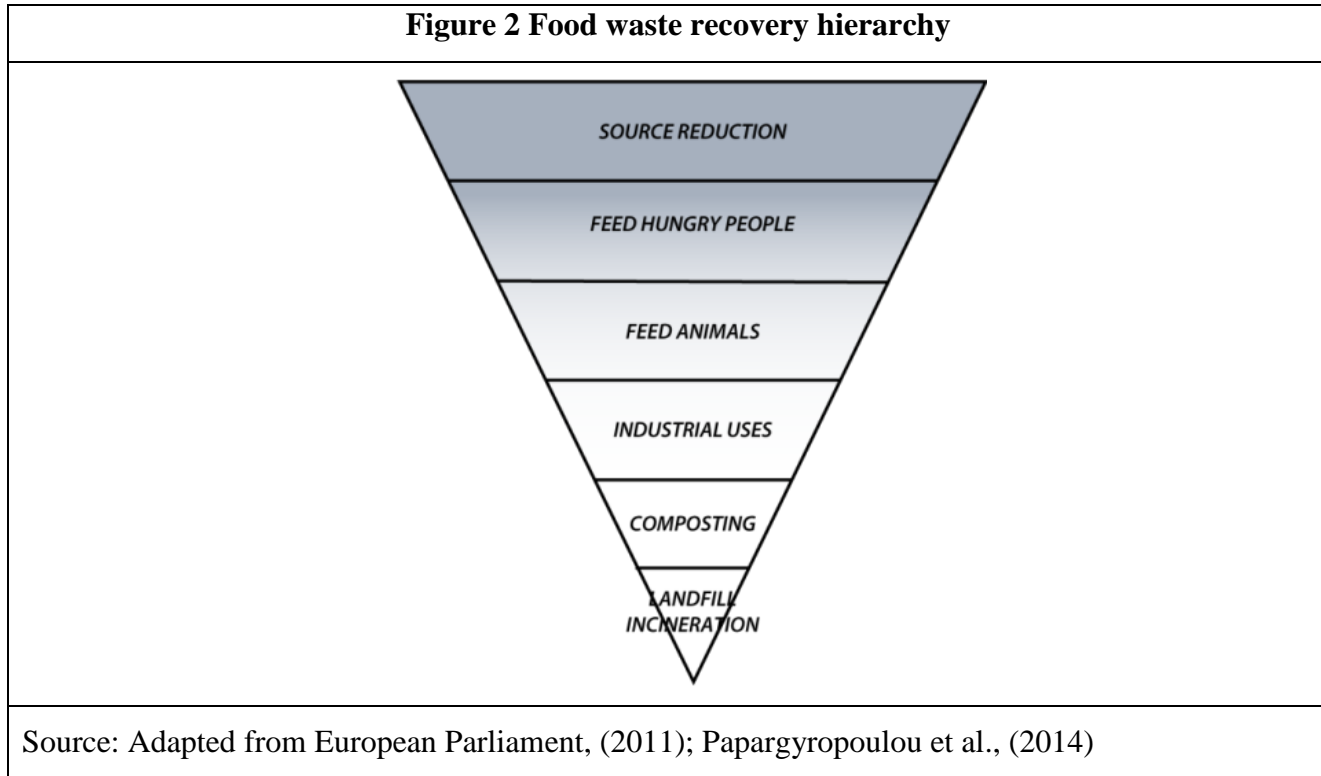
Figure 1 Preventive measures allocated within the waste hierarchy



Source: UE 2008/98/EC adapted to OECD EEA 2002: Case studies on waste minimisation practices in Europe

In this sense, to tackle food waste, it is important to differentiate between recycling and prevention concepts. Evidence from the UK indicates that among all strategies to prevent waste, the prevention of food waste is the one with the greatest potential (Cox et al., 2010). There is a specific food waste hierarchy (see Fig. 2) that transposes the hierarchy preferences to food management (European Parliament, 2011; Papargyropoulou et al., 2014). The hierarchy transposes the meanings of prevention, recycling and discarding to food. Thus, first it would be necessary to prevent the generation of food waste. Second, if waste could occur, food should be diverted to humans beforehand. Thirdly, if food cannot be reached by human consumption, it might be used to feed

179 animals by conversion of food surplus into feeding. Next, any other industrial uses are proposed
180 such as generation of energy, bio-energy, etc. And the last two levels of food waste recovery
181 hierarchy are food composting and finally landfilling.



182

183 There is a common tendency to relate waste reduction with recycling, although they are not the
184 same concepts. Some examples of waste prevention are the reduction of the amount of plastic
185 employed while shopping such as plastic bags or plastic packaging, repairing objects before buying
186 new ones, re using glass jars, etc. Recycling actions are more commonly known such as recycling
187 plastics, paper, etc. There is a debate in the scientific literature about the relationship between
188 prevention and recycling behaviours. Some authors consider them to be related (Cox et al., 2010)
189 and only the most environmentally encouraged or committed recyclers also act to prevent waste. By
190 contrast, others suggest that waste prevention behaviours are poorly or even negatively correlated
191 with recycling (Barr, 2007; Cecere et al., 2014; Tonglet et al., 2004b). These studies argue that
192 recycling may become a reason for decreasing the effort to reduce waste. Moreover a recent
193 publication found that the positive feelings of recycling can lead to using more quantity of the
194 material needed (Sun and Trudel, 2016). Variables that influence prevention and recycling are
195 diverse. Some authors, such as Barr, (2007); Refsgaard and Magnussen, (2009); Tonglet et al.,
196 (2004a); Zorpas and Lasaridi, (2013) suggested that recycling behaviour is influenced primarily by
197 opportunities, facilities and knowledge and, secondly, by not being deterred by issues of physically

198 recycling (e.g. time, space, inconvenience). Meanwhile, the factors that influence waste prevention
199 that are most cited in the literature are: universalism values and moral motivations, self-
200 responsibility to act, self-efficacy, cost, social norms, habits, strong environmental values and
201 knowledge about environmental politics (see Barr, 2007; Cox et al., 2010; Tonglet et al., 2004b).
202 As noted by previous authors the predictors of both are totally different and are quite diverse.
203 Therefore, we considered both behaviours to be distinguished.

204 Studies like Barr (2007) and Tonglet et al. (2004b) covered the issue of prevention and recycling
205 behaviour in a global scope, without focusing on one single act as in wasting food. More recently,
206 some studies have analysed the influence of food waste disposal, such as the use of the bio-waste
207 container, as an explanatory variable of food waste awareness and behaviour (Tucker and Farrelly,
208 2015; Visschers et al., 2016).

209 In the present work, we characterized food waste behaviour as a specific waste management
210 behaviour (Cecere et al. 2014). Prevention and recycling have different consequences, and we want
211 to find out to what extent food waste is influenced by prevention and recycling behaviours.

212 Thus, the following two hypotheses are considered:

- 213 • H4: Consumers who reveal more positive prevention behaviour are expected to reveal lower
214 food waste generation.
- 215 • H5: Consumers who reveal more positive recycling behaviour are expected to reveal lower
216 food waste generation.

218 ***2.3. Consumers' values***

219 Individuals' environmental concern may be an important indicator impacting food waste behaviour.
220 In fact, recent studies have shown consumers' environmental awareness about food waste
221 consequences (Neff et al., 2015; Principato et al., 2015). In particular, Cecere et al. (2014) indicate
222 a positive effect of Green Attitude on the perceived production of food waste using the
223 Eurobarometer Report of 2011¹ data. Other studies directly link environmental awareness to
224 positive environmental behaviours and waste minimisation (Barr, 2007; Kilbourne and Pickett,
225 2008; Tonglet et al., 2004a). Taking into consideration the relevance of individual environmental
226 values on the formation of specific waste prevention behaviours we propose the following
227 hypotheses to analyse its indirect and direct effect on food waste behaviour:

¹ Flash Eurobarometer 316. Attitudes of Europeans Towards Resource Efficiency

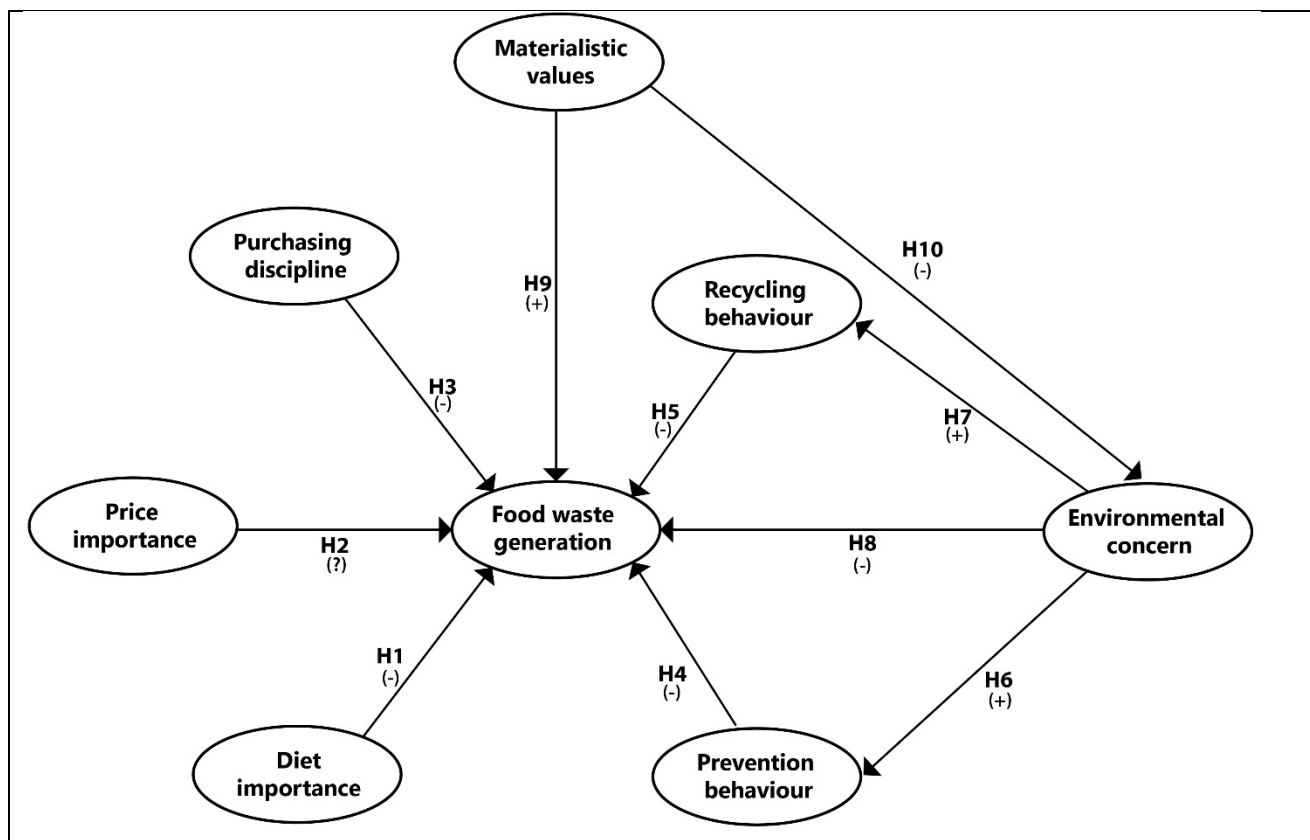
- H6: Consumers who reveal a high environmental concern are expected to demonstrate more positive waste prevention behaviour.
- H7: Consumers who reveal a high environmental concern are expected to demonstrate positive recycling behaviour.
- H8: Consumers who reveal a high environmental concern are expected to report less food waste generation

Finally, consumption habits in general could also influence food waste as mentioned by Parfitt et al. (2010) and WRAP (2007). We include in the model materialism values as a proxy of consumerism. Materialism understood as a value that attaches importance to material possessions and the pursuit of personal wealth (Richins, 2004). The relationship between materialistic values, environmental awareness and behaviour has been clearly established by previous literature. For instance, Hurst et al., (2013) estimated by means of a meta-analysis the correlation between materialism and environmental awareness, and between materialism and environmental behaviour. They noticed that materialism was negatively and equally related with both environmental awareness and environmental behaviours. Also, materialistic values were found to be negatively related to environmental beliefs, and these beliefs influence environmental awareness and environmental responsible behaviour (Kilbourne and Pickett 2008). Based on this evidence, we propose the final hypotheses for the model that states that:

- H9: Individuals' materialistic values have a negative influence on individuals' environmental awareness
- H10: Individuals' materialistic values have a negative influence on individuals' food waste behaviour.

A theoretical food-waste-values behaviour framework model has been defined (see Fig. 3) by taking into account all the considerations shown above. This model draws some paths of the decision-making process that consumers undertake when defining their food waste behaviour.

Figure 3 Theoretical framework of food waste predictors



3. Material and methods

3.1. The sample

We drew our sample from a survey conducted in the metropolitan area of Barcelona (Spain) in autumn 2013. We focused on the subset of consumers who were responsible for cooking or food purchase in their households. We distributed the survey on paper and online through different social media platforms and emails. We finally collected 418 responses. Individuals' characteristics are presented in Table 1 such as gender, age, area of residence, education, income and children in charge (see Table 1). Regarding to the implementation method, the questionnaire was, in most of the cases, self-administrated with available assistance in the case it was required (especially old people needed assistance for reading and understanding how to answer). The survey duration was of about 10 minutes. Both pencil-surveys and online form had the same format and order.

Table 1 Sample description

	<i>Frequency</i>	<i>% of the sample</i>
Gender		
Male	172	41.1
Female	246	58.9
Age >18		
18-34	179	42.8
35-49	110	26.3
50-64	102	24.4
More than 65	28	6.5
Studies		
Basics	84	20.1
Medium/superior	119	28.5
Graduate	211	50.5
Dk/na	4	1
Working status		
Employee	263	62.9
Entrepreneur	36	8.6
Pensioner	40	9.6
Unemployed	71	17.0
Dk/na	8	1.9
Housing structure		
Unipersonal	45	10.8
Couple	106	25.4
Family	234	56.0
Sharing apartment	33	7.9
Children under 16 at home		
None	292	69.9
1	69	16.5
2	37	8.9
3 or more	1	1
Dk/na	16	3.8

3.2.Survey and measures

The questionnaire included 44 questions to build the hypothesized model. A seven-point Likert scale was employed for all questions. Questions scales were in many cases adapted from validated scales such as environmentalism (Dunlap et al., 2000), materialism (Kilbourne and Pickett, 2008; Richins, 2004) and waste recycling and waste prevention (Barr, 2007), the remaining scales were designed by the authors based on previous experience. The final model was formed by 24 indicators due to model specifications explained below. Table 2 summarizes the characteristics of all latent variables and indicators included in the model. It can be observed that the model includes three

constructs to capture food-related behaviours: purchasing discipline defined by two items, price importance formed by one item and finally importance of diet measured by three indicators. Two four-items constructs were considered for waste-related behaviour, recycling and prevention. Next, two dimensions represented consumer's values on materialism, which included four items, and second environmental concern with two items. Finally, food waste generation included six items.

The survey had a short introduction² asking consumers participation on a food survey. Then, all Agree-Disagree questions (purchasing disciplines, price importance, diet importance, materialism values and environmental concern) were randomly presented, next waste-related questions randomly ordered and finally food waste assessment. Food waste questions were placed at end to avoid interaction between food waste questions and other behaviours under analysis. It has a specific explanation to clarify participants' responses "*Following you should think on the amount of food that you have thrown away that otherwise could have been eaten during the past month. Everything which cannot be eaten such as potatoes peels, bones, etc. are not included. You may think on the food that is thrown away through the trash bin, the organic bin, the compost or what you give to your pet.*" Both online and paper survey had the same structure.

3.3. Analytical procedures

To test relationships among non-observed variables (latent variables) one may opt to use structural equation modelling (SEM) which is a second-generation type of modelling (Fornell and Larcker, 1981; Hair et al., 2014; Kline, 2011). There are two types of SEM, the covariance-based SEM (CBSEM) and the variance based (PLS-SEM). The former is applied to confirm or reject solid theories by estimating the covariance matrix of the data. The latter, is primarily applied in exploratory research to develop new or on early stages theories looking into the variance in the dependent variables (Hair et al., 2014). PLS intends to test how the theory fits the data, the fit of the model in PLS-SEM test the discrepancy between the observed values and the values predicted by the model in question. The objective of PLS is to maximize the variance explained rather than the fit. Due to the novelty approach of combining waste-related, food-related and values-related as a predictors of food waste, we used PLS-SEM to validate the hypotheses formulated above.

PLS technique is gaining adepts due to its flexibility in comparing theory and real data, soft distributional assumptions, its exploratory and prediction-oriented nature, its compatibility with

² Good morning/good afternoon. My name is Raquel Diaz, I am student from the Polytechnic University of Catalonia. We are doing an investigation about food in the metropolitan area. We guarantee complete anonymity of your responses. It would take you around 10 minutes. Could you please collaborate with the study? We appreciate your participation:

model complexity and its ease of model interpretation among other. PLS can estimate a model with a large number of latent variables and indicators with small sample sizes (Chin et al., 2008). As noted by Akter et al., (2017), PLS-SEM has been used to analyse more latent variables and including more indicators per model on average than in the CBSEM. In their systematic review, they found that CBSEM accounted for 4.4. latent variables and 14 indicators, whereas PLS 8.12 latent variables and 27.42 indicators were included. PLS also gives the flexibility to include one-single item latent variables, it has no a restriction of at least three-items per latent as in CBSEM. To assess the validity of the model, a two-stage analytical procedure is used. First, the assessment of the measurement model to evaluate the correctness of the latent variables and indicators. And, secondly the structural model relationships and predictive power. Contrary to the CB-SEM, where the two stages are consecutive, the PLS-SEM uses the complete model with the relationships between latent variables from the beginning.

Smart PLS (v.3.2.6.) (Ringle et al., 2015) was used to deduce the model. In the following section all the stages and validation statistics are explained in detailed.

4. Results

4.1. Descriptive results

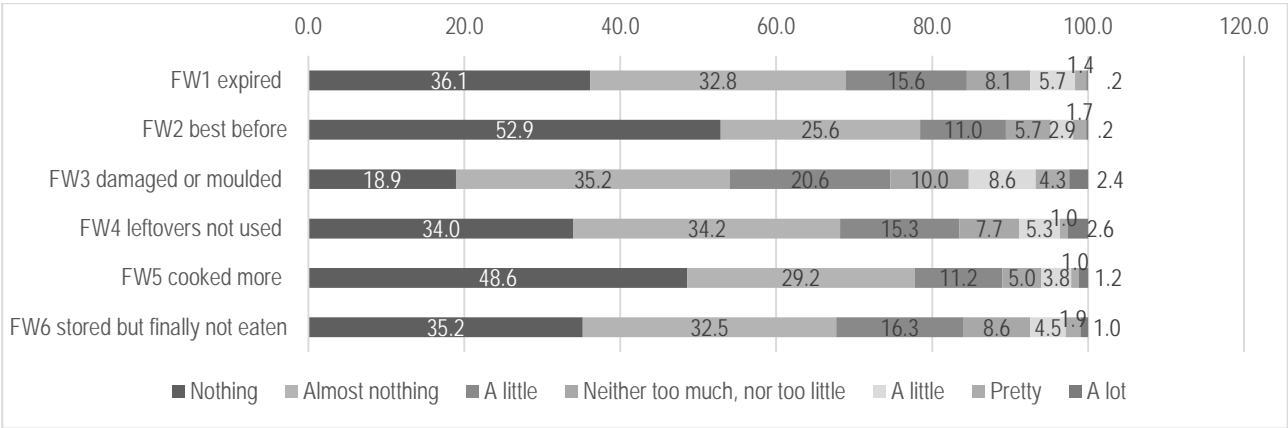
The first part of this section provides some descriptive results of the different constructs considered in the model. Table 2 summarizes the characteristics of the indicators included in the model, reporting the statements, its mean and standard deviation (SD) as well as the frequency of response distribution within the 7-point Likert scale. These responses have been grouped in three levels: negative from 1-3, neutral 4 and positive form 5-7. We tested the normality of all indicators by means of the Saphiro-Wilk test confirming the non-normal distribution (p-value =0.000) of all observed variables.

Regarding to food related behaviours, respondents revealed to have a disciplined attitude during shopping. In fact, 60.3 % declared they ‘buy only what they need’ and they ‘do a shopping list’ (67.2%). Consuming cheap food is important for almost half of the sample (52.2%) and diet seemed to be important in their food choices. Above the 70% of the sample showed interest in eating food ‘rich in vitamins’ (74.2%), ‘low fat food’ (70.8%) and ‘food free of potential hazardous ingredients’ (80.4%).

340 Regarding to waste recycling and prevention habits, the sample affirmed to have a very high
341 recycling and prevention behaviour. For instance, 82% of the households do recycle glass, this
342 percentage decreased to 80%, 70% and 60% in the case of domestic packaging, paper and organic
343 waste, respectively. In terms of waste prevention, both reusing and reduction were included on the
344 survey. The most frequent reusing activity, that 82.3% of respondents declared to do often or
345 always, was trying to repair things before buying new items as well as reusing paper. On reduction
346 activities the most frequent one was using their own shopping bag.

347 With respect to values, respondents reported low materialism values and high environmental
348 concern. Indeed, they most likely tend to disagree on being happier buying more things or acquiring
349 possessions as a sign of achieving. Furthermore, 75% of the sample do not agree on admiring
350 people who own expensive homes, cars and clothes. However, almost half of the sample admits that
351 they would be happier if they owned certain things they don't. As regards environmental concern, a
352 high percentage of respondents agree that if things continue on their present course, we will soon
353 experience a major ecological catastrophe (76.8%). We do not observe the same consensus on the
354 statement 'The so-called "ecological crisis" facing humankind has been greatly exaggerated' where
355 the opinion is more divided and only half of the sample do not agree with it.

356 Concerning food waste generation, most of participants claimed to generate very little food waste
357 (see Fig. 4). The question included the most common situations in where food can be thrown away.
358 The situation with higher mean (2.8 out of 7) is when food has been damaged or moulded.



359
360 **Figure 4 Food waste behaviour results per situation**

Table 2 Latent variables and indicators description

		Mean	SD	Distribution within 7-point Likert scale (%)		
				1-3	4	5-7
Purchasing discipline (PUR)	To what extend do you agree with the following statements (1 Totally disagree - 7 Totally agree)					
PUR1	I usually buy only the things I need	4.8	1.7	25.6	14.1	60.3
PUR2	I do a shopping list with what I need when I go shopping	5.1	2.0	22.0	10.8	67.2
Price importance (PI)	To what extend do you agree with the following statements (1 Totally disagree - 7 Totally agree)					
PRI1	It is important to me that food I consume is cheap	4.4	1.7	27.3	20.6	52.2
Diet importance (DIET)	To what extend do you agree with the following statements (1 Totally disagree - 7 Totally agree)					
DIET1	Eating food rich in vitamins is important to me	5.5	1.4	8.6	17.2	74.2
DIET2	Eating low fat food is important to me	5.2	1.6	13.4	15.8	70.8
DIET3	Eating food free of potential hazardous ingredients such as pesticides is important to me	5.8	1.7	12.4	7.2	80.4
Recycling behaviour (REC)	Could you please indicate how often do you the following? (1 Never - 7 always)					
REC1	I recycle glass	5.9	1.9	12.4	5.0	82.5
REC2	I recycle paper	5.6	2.0	17.0	7.2	75.8
REC3	I recycle domestic packaging	5.8	1.9	13.2	6.0	80.9
REC4	I recycle organic waste	4.7	2.3	29.7	10.5	59.8
Prevention behaviour (PREV)	Could you please indicate how often do you the following? (1 Never - 7 always)					
RED1	I use my own bag when going shopping, rather than one provided by the shop	5.8	1.6	10.0	7.7	82.3
RED2	I buy products that can be used again, rather than disposable items	4.8	1.6	17.2	23.0	59.8
REU1	I try to repair things before buying new items	5.6	1.4	6.7	11.0	82.3
REU2	I reuse paper	5.3	1.9	16.7	9.6	73.7
Materialism values (MAT)	To what extend do you agree with the following statements (1 Totally disagree - 7 Totally agree)					
MAT1	My life would be better if I owned certain things I don't have	4.3	1.9	30.1	20.6	49.3
MAT2	I'd be happier if I could afford to buy more things	3.2	1.8	56.2	18.4	25.4
MAT3	I admire people who own expensive homes, cars and clothes	2.3	1.7	75.6	14.4	10.0
MAT4	Some of the most important achievements in life include acquiring possessions	3.4	1.8	52.6	18.4	28.9
Environmental concern (ENV)	To what extend do you agree with the following statements (1 Totally disagree - 7 Totally agree)					
ENV1	The so-called "ecological crisis" facing humankind has been greatly exaggerated (R)	4.8	1.9	24.9	16.5	58.6
ENV2	If things continue on their present course, we will soon experience a major ecological catastrophe	5.5	1.5	11.2	12.0	76.8
Food waste generation (FW)	The amount of food I have thrown away in a recent week because ...(1 Nothing - 7 A lot)					
FW1	it has expired is ...	2.2	1.3	84.4	8.1	7.4
FW2	it has passed the best before date is...	1.9	1.2	89.5	5.7	4.8
FW3	it has been damaged or moulded such as stale bread, etc. is ... (stored in the fridge or cupboards)	2.8	1.5	74.6	10.0	15.3
FW4	I have leftovers and I have not used them for another meal is ...	2.3	1.4	83.5	7.7	8.9
FW5	I cooked more than I needed and I have not used it for another meal is....	1.9	1.3	89.0	5.0	6.0
FW6	I had stored from previous meals but finally I have not eaten is...	2.2	1.3	84.0	8.6	7.4

4.2. Measurement model evaluation

The measurement model was validated following the recommendations of (Hair et al., 2014). There are three main stages to do so: the assessment of item reliability, the convergent validity and the discriminant validity. The model consisted on 26 observed variables (OV) forming eight latent variables (LV). The OV excluded from the model did not accomplish the requirements.

4.2.1. Item reliability

According to the results showed in Table 3, all latent variables' composite reliability (CR) values are above 0.7 which indicates good internal consistency reliability (Fornell and Larcker, 1981). We opted to rely only on the composite reliability as a measure of the internal consistency, to the detriment of the Cronbach's alpha. Cronbach's alpha tends to underestimate the internal consistency and is sensitive to the number of items involved as well as to the sample measure (Hair et al., 2014; Xu et al., 2016). In our case, we have a wide range of LV items composition (a single-item, two items LV, etc.), that can affect the results of the statistic. Therefore, we decided to dismiss Cronbach's alpha criterion from our analysis.

4.2.2. Convergent validity

Convergent validity, which explains the positive correlation of a measure with alternative measures of the same construct, was tested by means of the average variance extracted (AVE). To do so, we first analyse the outer loadings of every indicator and second, we assessed the AVE's values for the LV. All indicators outer loadings are statistically significant as it is shown in Table 3, see t-values (the common used critical values for two-tailed test are 1.96 with 5% of significant level). In addition, most of the outer loadings are above 0.7 which means that the variance shared between the construct and the indicator is larger than the measurement error variance. There are seven outer loadings bellow that rule of thumb, however they are above 0.5. As pointed out by, Hair et al., (2014) citing Hulland, (1999) in social sciences when new scales are developed it is frequent to obtain lower outer loadings. Moreover, we have implemented the outer loading relevance testing for indicators with an outer loading below 0.7. Since the deletion of the outer loading below 0.7 has not increased the AVE and CR we decide to keep those indicators in the model. For a single-item construct (Price importance), the AVE is not an appropriate measure as the outer loading is fixed at 1.00. All of AVE are above 0.5, which indicates that the construct explains more than half of the variance of its indicators and therefore satisfies the criteria of convergent validity (Fornell and Larcker, 1981).

Table 3 Reliability measurements

	<i>outer loading</i>	<i>t-statistic outer loading</i>	<i>Composite Reliability</i>	<i>Average Variance Extracted (AVE)</i>
Purchasing discipline (PUR)			0.774	0.631
PUR1	0.818	11.056		
PUR2	0.770	8.779		
Price importance (PI)			1.000	1.000
PRI1	1.000			
Diet importance (DIET)			0.783	0.548
DIET1	0.757	4.835		
DIET2	0.803	6.356		
DIET3	0.653	4.512		
Recycling behaviour (REC)			0.936	0.786
REC1	0.916	61.966		
REC2	0.915	72.756		
REC3	0.943	101.263		
REC4	0.761	24.994		
Prevention behaviour (PREV)			0.807	0.512
RED1	0.664	12.243		
RED2	0.726	17.624		
REU1	0.720	14.021		
REU2	0.749	17.922		
Materialism values (MAT)			0.814	0.531
MAT1	0.594	6.693		
MAT2	0.849	25.824		
MAT3	0.851	24.844		
MAT4	0.572	5.719		
Environmental concern (ENV)			0.723	0.589
ENV1	0.960	13.417		
ENV2	0.506	2.459		
Food waste generation (FW)			0.888	0.572
FW1	0.641	10.379		
FW2	0.693	12.444		
FW3	0.749	19.696		
FW4	0.811	31.439		
FW5	0.807	21.314		
FW6	0.818	24.361		

397

398 *4.2.3. Discriminant validity*

399 As shown in Table 5, the discriminant validity is satisfied. We examine cross loadings of the
400 indicators to asses to what extend every LV is different from the others, say they are measuring
401 different things. We applied the Fornell-Larcker criterion where we compare the square root of the
402 AVE values (in bold in the diagonal) with the latent variable correlation (off-diagonal).

403 We tested the possibility of having the prevention behavior break up in two dimensions measured
404 by different constructs as proposed by Barr (2007) in the original scale. However, we detected
405 problems of discriminant validity between them. Thus, both reusing and reducing behaviours have

406 been considered under the same latent variable called prevention³. The higher correlation found
 407 between every pair of LV was between recycling behaviour and prevention behaviour (r=0.539).

408 **Table 5 Fornell-Larcker test of discriminant validity**

	DIET	ENV	FW	MAT	PRE	PI	PUR	REC
DIET	0.740							
ENV	0.076	0.767						
FW	-0.144	-0.048	0.756					
MAT	-0.120	-0.151	0.248	0.729				
PRE	0.306	0.236	-0.382	-0.293	0.715			
PI	0.160	-0.085	0.067	0.210	-0.028	1.000		
PUR	0.275	0.029	-0.253	-0.157	0.336	0.096	0.794	
REC	0.183	0.170	-0.287	-0.288	0.539	-0.026	0.290	0.887

Diagonals in bold represent the square root of each construct's AVE. Off-diagonals are the latent variable correlations.

409

410 **4.3. Structural model evaluation**

411 Once we have established the reliability and validity of the constructs we proceed to examine the
 412 structural model which estimates hypothesized paths between exogenous and endogenous latent
 413 constructs. It was evaluated by collinearity assessment, path significance, coefficient of
 414 determination and the predictive accuracy.

415 The first step is to assess structural model for collinearity issues. In the proposed model there were
 416 no presence of co-linearity in the structural model since all Variance Inflation Factors are below the
 417 critical value of 5 (Hair et al., 2014).

418 PLS is a non-parametric technique. Thus, the bootstrapping procedure needs to be applied to obtain
 419 the significance of the paths. A 5000 sub-samples bootstrapping was applied to compute the
 420 empirical t values of the relationships in the model. Table 6 shows the path coefficients of all
 421 hypotheses and its t-values with the associated p-value. From the results, we can support
 422 hypotheses 4, 9 and 3. That is, there is a significant and negative association between waste

³ A factor analysis was employed to decide if reusing and reducing behaviours can be included in a common factor. A principal component analysis was conducted on the 8 items with oblique rotation (direct oblim). The Kaiser-Meyer-Okin measure verified the sampling adequacy for the analysis, KMO = 0.851. Two factors have eigenvalues over Kaiser's criterion of 1 and in combination explained 65.6% of the variance. The pattern matrix after rotation reveals two factors representing recycling and prevention. As regards of reduction and reusing variables it is confirmed that they are not statistically different dimensions.

prevention and food waste (path coeff. = -0.272, t-value = 4.493), a significant and positive association between materialism values and food waste (path coeff. = 0.124, t-value = 2.504) and finally a significant and negative association between purchasing discipline and food waste. On the contrary, hypotheses 1, 2, 5 and 8 cannot be supported. Non-significant results were found for the negative and direct association between diet importance and food waste (path coeff. = -0.011, t-value=0.216), the direct and positive association between price importance and food waste (path coeff. = 0.049, t-value=1.011), the direct and negative association between recycling behaviour and food waste (path coeff. = -0.075, t-value=1.205) and finally the direct and positive association between environmental concern and food waste (path coeff. = 0.056, t-value=1.023). With regard to other model paths, we can observe a significant relation between materialism values and environmental concern (path coeff. = -0.151, t-value=2.339) supporting hypothesis 10. Finally, environmental concern was significantly, directly and positively linked with both prevention behaviour (path coeff. = 0.236, t-value=4.383) hypothesis 6 and recycling behaviour (path coeff. = 0.170, t-value=3.229) hypothesis 7. All in all, six out of ten hypotheses were supported. Figure 5 presents a summary of the measurement and structural model.

Table 6 Significance analysis of the structural model

<i>Hypotheses</i>	<i>Path</i>	<i>Path coefficient</i>	<i>t-value</i>	<i>p-value</i>
H1	DIET→FW	-0.011	0.216	0.829
H2	PI→FW	0.049	1.011	0.312
H3	PUR→FW	-0.124	2.539	0.011
H4	PRE→FW	-0.272	4.450	0.000
H5	REC→FW	-0.075	1.205	0.228
H6	ENV→PRE	0.236	4.383	0.000
H7	ENV→REC	0.170	3.229	0.001
H8	ENV→FW	0.056	1.023	0.307
H9	MAT→FW	0.124	2.398	0.017
H10	MAT→ENV	-0.151	2.339	0.019

Finally, the overall potential explanatory power of food waste generation in the model equals 19.0% ($R^2=0.190$), which is similar to the values found in previous studies analysing waste prevention behaviour (Barr, 2007; Stancu et al., 2016). Low coefficient of determination values as 0.20 can be considered high in the consumer behaviour discipline (Hair et al., 2011; Henseler et al., 2009). All coefficient of determination R^2 values of the latent constructs are shown in Table 7. The power in predicting the rest of exogenous LV is weak, below 6.8% of the variance explained. Yet, by examining the predictive accuracy of the endogenous constructs by means of Stone-Geisser's Q2

value we confirmed the predictive relevance of every endogenous construct in the model (Environment concern = 0.008, Food waste = 0.090, Prevention = 0.025 and Recycling = 0.020). To assess the Q^2 values a blindfolding procedure needs to be applied (see Hair et al., (2014)for details). Values larger than zero indicate a satisfactory predictive relevance. Finally, environmental concern has a significant indirect effect towards food waste through recycling and prevention (0.077, p-value = 0.001).

Table 7 Coefficient of determination and predictive relevance of endogenous latent variables

	R ²	Q ²
Environmental concern (ENV)	0.023	0.008
Food waste generation (FW)	0.190	0.090
Prevention behaviour (PREV)	0.056	0.025
Recycling behaviour (REC)	0.029	0.020

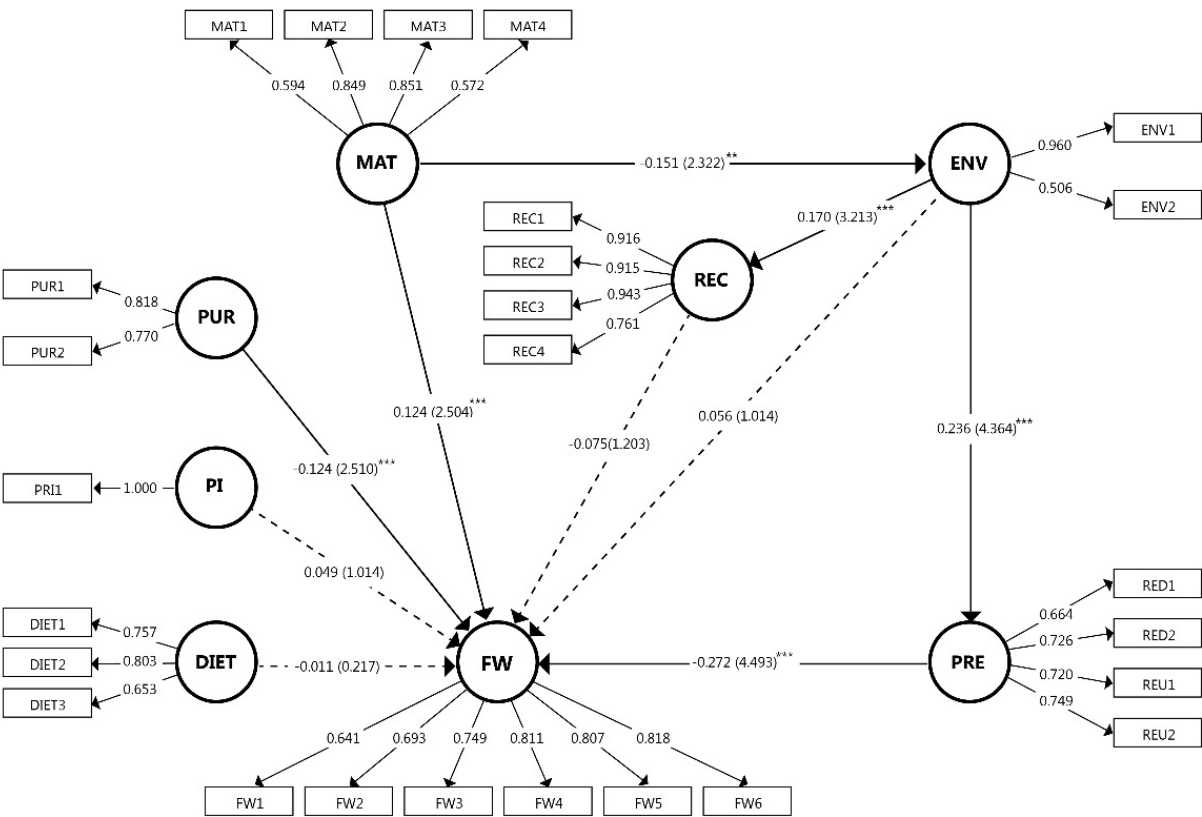


Figure 5 Measurement and structural model to predict consumer food waste behaviour

459 **5. Discussion and conclusions**

460 Over the past decade, many public institutions such as FAO, UN, the European commission or
461 USDA among others together with NGOs and further stakeholders have alerted the society about
462 the increasing amount of food being produced but not eaten. Some reports intended to quantify the
463 amount of food lost or wasted within the different stages of the food chain reaching the conclusion
464 that households are important points to be assessed due to the big amount of waste that they
465 generate. In order to reduce household food waste a better understanding of the reasons that build
466 consumers food waste behaviour is needed. Up to now a big part of the food waste literature is
467 focused on the analysis of consumers' food attitudes to explain food waste behaviours. However,
468 we argue that the environmental dimensions of consumers' actions together with consumer values
469 can also play an important role in that behavioural process. To do that we developed a model that
470 combine food-related and waste-related behaviours together with environmental and materialism
471 values to explain household food waste behaviours.

472 It is the first time, to our knowledge, that food-related and waste-related behaviours and
473 environmental and materialism values are used in the same model to predict food waste generation.
474 To do the analysis we employed PLS-SEM, classified as soft modelling techniques where the
475 exploratory nature of the models prevails to the confirmatory one. The results obtained from our
476 model confirmed our hypothesis that food waste behaviour is a complex issue that needs to be
477 analysed with an integrative approach. Overall, the main results of the present study suggest that
478 consumers' purchasing discipline, waste prevention behaviours and materialism values are useful
479 direct predictors of food waste behaviour. Specifically, high and committed waste prevention
480 behaviour influences to declare low food waste generation. Also, a disciplined purchasing
481 behaviour – namely doing a shopping list or buying only what it is needed - also predicts lower
482 food waste generation. Finally, the higher the materialistic values a consumer has the higher the
483 amount of food waste he/she declares to generate. Moreover, we want to highlight that all three
484 factors resulted equally important to predict food waste. In addition of the direct predictors indirect
485 relations have also been identified. This is the case of environmentalism concern, that indirectly
486 influence food waste perceived behaviour through waste prevention. Finally, we cannot assure that
487 recycling behaviour, price and diet importance have an influence on food waste behaviour.

488 **5.1. Research implications**

489 We contribute to the literature supporting previous research mentioned in section 2 and developing
490 a new angle for the understanding of household food waste generation. New variables considered

491 are consumers' purchasing discipline, price importance and diet importance. We are aware that
492 recent studies demonstrated that other food factors such as date labelling knowledge and preference,
493 planning, marketing sale attractions or leftovers management are also important to undertint the
494 formation of consumers' food waste behaviour. Therefore, we suggest a further analysis must be
495 performed consider all those factors together

496 Another contribution refers to the recognition of a relation between high environmental concern and
497 positive recycling behaviour contrary to previous work Barr (2007); Refsgaard and Magnussen
498 (2009); Tonglet et al. (2004a) who noticed that individuals' recycling behaviour is not conditioned
499 by their environmental values and does not determine their waste behaviour. With our results, we
500 cannot ensure that recycling has a predictive effect on food waste generation. It is interesting to
501 highlight that our model reveals a lack of differentiation between two dimensions of waste
502 prevention behaviour that have been considered in other works as conceptually different. Waste
503 reducing and prevention have been jointly treated in this study for three main reasons. First, Barr,
504 (2007), in his seminal paper, already indicated that both variables are very similar in people's mind.
505 Second, previous research carried out in Catalonia (Díaz-Ruiz et al., 2015) corroborated this idea.
506 Third, a discriminant analysis validated it. For future studies, it would worth it keep them separate it
507 in order to evaluate the evolution through time. Moreover, other regions from Europe with other
508 waste management background might have different outcomes.

509 This paper also contributes to the literature by relating materialism with environmentalism concern
510 and with a specific environmental behaviour as food waste generation. The relationship between
511 materialism and environmentalism is negative and significant confirming evidences from Hurst et
512 al.,(2013) meta-analysis and Kilbourne and Pickett's (2008). We also tested in the same model, as
513 recommended by Hurst et al., (2013), a direct relationship between environmentalism values and
514 food waste generation. The relationship was positive and with almost the same intensity than
515 towards environmental concern. These relationships are important, significant and negative,
516 supporting Hurt et al. Moreover our model also supports the studies that relate consumerism culture
517 life with food waste (Parfitt et al., 2010; WRAP et al., 2007; WRAP and Qusted, 2009).

518 Finally, it is important to take into account that consumer behaviour is measured on a self-report
519 basis. As seen in Figure 6, people tend to answer that they do not generate food waste, or only a
520 little. Interestingly, results coincide with the answer about the amount of food wasted in the
521 Eurobarometer Flash EB Series 316 (European Commission, 2011), in which 71% of respondents
522 believe they throw away less than 15% (is the answer with the lowest percentage) of the food they
523 buy. In addition, in the latest version of Euro Barometer Flash EB Series 388 (European

Commission, 2014), people tend to say that they generate less food waste than in 2011. It seems that this is a general trend in consumer food waste self-reporting. In Neff et al., (2015) 73% of the sample reported that they discarded less than the average American, or, in Mondéjar-Jiménez et al., (2015), more than 75% of both groups in Italy and Spain reported that they waste none or up to 15% of the food (the second category available) that they purchased. The lack of official and cross-sectional data makes it difficult to evaluate if the estimations of consumers are correct. There is a debate on the literature between the positive and negative effects of self-reporting. On the one hand, Kormos and Gifford (2014) argue that there is a great variance (79%) between the objective behaviour and the self-reported, which remains unexplained. And, on the other hand, Milfont (2009) advocates the lack of empirical studies testing the effect of social desirability on self-reported environmental attitudes and ecological behaviour. We suggest testing different typologies of consumer food waste self-reporting and comparing those tests with real data for future studies. Improving the dependent variable variance will improve the predictive power of the models.

We encourage researchers to include variables from both perspectives, food and waste management to analyse consumers' food waste behaviour and to deepen in other cultural values such as materialism. Statistical modelling and consumers' studies have their limitations on the number of constructs we can capture from a single sample – such as the length of surveys, the cost of collecting data or the statistical performance of multiple hypotheses at the same time. However, there is a wide literature contributing to fill the gaps and improve the models. Our aim with this study was two-fold contributing to the academic literature and providing evidences to policy makers to better address food waste prevention. On the former we acknowledge the need for further empirical evidence and we encourage other researcher to include the variables proposed in the present model to their future studies, prioritizing waste prevention, shopping discipline and materialism values.

5.2. Policy implications

Given the urgency of the situation, structural changes need to be done to achieve significant reductions of food waste as indicated by the United Nations' SDGs. To do so, we encourage policymakers to treat the issue using a multiple dimension strategy, and involving as much expertise as possible to embrace the whole complexity of the food waste conundrum. Using this type of approach behavioural changes may be reached and last over time moving consumer to construct a more sustainable society.

555 We want to highlight the relevance of the prevention behaviour for food waste reduction. We
556 perceive that prevention behaviour is a complex issue very often confused with recycling
557 behaviours. Nevertheless, to prevent is not the same as to recycle, and the food waste prevention
558 campaigns should address the first in order to reduce waste generation. In addition, European
559 environmental legislation (UE 2008/98/EC) recommends to perform prevention actions as the first
560 option in the hierarchy to manage waste, as shown in Figure 1, but to date it does not receive
561 sufficient attention. As cited by the House of Lords (2014) according to FareShare⁴: ‘at the
562 moment, we have a waste hierarchy that is completely out of kilter with the economic hierarchy that
563 sits alongside it’. It could create the temptation to prioritize energy recovery over redistribution or
564 prevention. Researchers and policy institutions should be able to facilitate the first stages of the
565 food waste prevention pyramid (see Fig. 3) by providing evidence and promoting certain
566 regulations to encourage food waste prevention. Campaigners might be careful not to confuse
567 consumers with the concepts of recycling, sorting or composting with prevention and not generation
568 of waste. Sorting organic waste or composting at home could be seen as a way of being more
569 concerned about food waste, but research on this specific topic is needed to find out the effect of
570 food sorting.

571 In Europe, food waste prevention emerged from waste sectors. As Lucifero (2016) pointed out food
572 waste definition in Europe is more environmentally oriented and especially waste oriented. This fact
573 could influence food waste prevention initiatives, but our research encourages policymakers to pay
574 greater attention to food-related variables on food waste prevention campaigns. Notwithstanding,
575 simplifying it to mere tips on food management could be counterproductive. The results of our
576 survey and a previous one in the same region (Díaz-Ruiz et al., 2015) revealed high self-evaluations
577 in purchasing discipline, for example, making a shopping list, organizing the fridge or developing
578 cooking skills. Indeed, changing prevention behaviours is not as easy as influencing recycling
579 behaviours, as demonstrated in different studies to date. Prevention behaviours are influenced by a
580 set of actions and values distant from materialistic or direct economic issues. Furthermore, food
581 waste prevention, in particular, could be even more complex than other behaviours, such as energy
582 efficiency in households. As explained by Quested et al. (2013), turning off the lights has a direct
583 consequence, seen by the user (reducing the light bill, for instance), that food waste reduction does
584 not have. Food waste consequences happen outside of home and could be diverse: economic, social
585 and environmental among others. We finally recommend including the discussion of current
586 consumerism lifestyle into the debate. And to include values-based campaigns in the food waste

⁴ <http://www.fareshare.org.uk/>

587 prevention agenda as previously proposed by other authors in the environmental field (Hurst et al.,
588 2013). This could be translated in proposing less resources consuming lifestyles, more frugality
589 related to decrease materialism values of individuals.

590 **5.3. Final remark**

591 To achieve the goal of reducing global food waste, special attention needs to be paid to individual
592 households. It is necessary to understand consumers' behaviour and attitudes towards food waste
593 generation and prevention. Since wasting food is caused by multiple factors, this paper proposes a
594 model to encourage both researchers and policymakers to broaden the perspectives and combine a
595 diversity of approaches to depict factors influencing the generation of food waste. And eventually,
596 more appropriate and effective solutions will be designed.

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598
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